Dear Editor and the reviewer,

We are very grateful to your constructive comments and thoughtful suggestions. Based on these comments and suggestions, we have made thorough revisions to the original manuscript. In addition, we polished our language by the highly qualified native English-speaking editors at AJE in the revised manuscript. The changes made to the text are highlighted in blue so that they may be easily identified in the revised manuscript. Above these have led to an improvement of the paper, and we hope the revised manuscript is suitable for publication in the journal.

Yours sincerely,

Tonghua Wu on behalf of all co-authors

Response to comments:

As reviewers 1 and 2 stated, I agree that the dataset would be useful for permafrost communities, including general geocryology, permafrost modeling, etc. This manuscript was generally organized well. The observational system is maintained well during the past decade. Besides the comments from reviewers 1 and 2, I also have some further comments.

Major comments

1 As a data description paper, the authors should make all data descriptions clear and correct. I list a few of the issues here (not limit to these. The authors should read and double-check thoroughly).

Response:

We are very grateful to your constructive comments and thoughtful suggestions. Based on these comments and suggestions, we have made thorough revisions to the original manuscript. The changes made to the text are highlighted in blue so that they may be easily identified in the revised manuscript.

We have listed our point-to-point response to every comment as follows.

(1) In table 1, air temperature is monitored at two heights (2m and 4m). In Figure 2, the air temperature sensor (the arrow indicated) looks like at 4m height, if the GST sensor is rightly at 2m. In Figure 3a, which one was shown here?

Response:

The air temperature in Table 1 is right. In Fig.2, there are two air temperature sensors that installed in 2m and 4m height, but only the sensor at 4m height is labelled with red arrow.

The LST sensor at 2m height is also right, because it is non-contact infrared radiation sensor. In the Fig. 3a, air temperature at 2m height is shown, we have added this information in the Line of 164.

To be clear, we explained the information in the figure legend of Fig. 3 as follows:

Figure 3. Time series of meteorological variables from 2010 to 2020 at Mahan Mountain, including air temperature at 2 m height (a), land surface temperature (b), precipitation at 1.6 m height (c), shortwave radiation at 2 m height (d), longwave radiation at 2 m height (e), water vapor pressure at 4 m height (f), relative humidity at 4 m height (g), wind speed & direction at 2 m height (h). The temporal resolution of precipitation data is daily scale, and hourly scale for other all variables.

(2) The authors should note the date of the field picture (during the station was established?). If the surface always looks like this, the observations should be significantly different from the surrounding. Because the vegetation looks different from the surrounding area.

Response:

Fig. 2a was recorded on June 15, 2020, which has been added in the figure caption of Fig. 2a.

When the station was established, there was no fence around the whole field. Subsequently, we found that some sensors were damaged by yaks and sheep. Therefore, we had to setup the fence to protect these sensors from local grazing herds. However, the existence of no fence can cause the significant differences in vegetation condition inside and outside of the fence. We mowed vegetation periodically inside of the fence and try to keep same condition of inside and outside. We explained this in the figure legend as follows:

Note that we selected flat ground with the same vegetation type to set up the instruments. While some instruments were destroyed by animals, so we set up a fence to protect the instruments. There were slight differences in the vegetation biomass during the following years. (Line 157-160)

(3) Figure 3, what temporal resolution is showing here? Hourly, daily, or others?

Response:

Time series of meteorological variables in Fig. 3 are based on daily precipitation data (c) and hourly records for all other variables (a–b, d–h). We have added this information in the revised manuscript, which is as follows:

The temporal resolution of precipitation data is daily scale, and hourly scale for other all variables. (Line 175-176)

(4) For precipitation, I don’t know what mean annual precipitation is (line 186). From Figure 3c, the maximum is < 30mm. I guess they are annual totals?

Response:

Thank you very much for pointing this out. The “mean annual precipitation (line 186)” has been changed into “annual total precipitation” in the revised manuscript, the detailed descriptions are as follows:

The observed local annual total precipitation was 318.6 ± 54.3 mm from 2010 to 2020, and the minimum and maximum annual total precipitation occurred in 2015 and 2018 with values of 258.3 mm and 443.9 mm, respectively.

(Line 203-205)

(5) Figure 6, y-axis: the unit is meter? Or cm? Why was there an anomaly peak at ~60 (m/cm?) at 9# during Aug 2016 (i.e., Figure 6e)?

Response:

The unit of depth in y-axis is centimeter, in the revised manuscript, we have changed it.

There exist an anomaly peak value of soil moisture at 9# during Aug. 2016, these data are acquired using standard oven drying method. We analyzed it and concluded that there might exist subsurface flow at depth of 60cm or so, which could cause greater soil moisture values. In the revised manuscript, we have added this information, which is as follows:

The abnormally high value at a depth of 60 cm at site 9# during August 2016 is likely related to the existence of subsurface flow. (Line 359-360)

(6) Table 2, range of VWC is 0-100%? Generally, it should be 0-1 because VWC has a unit of m3/m3. Actually, the author did show that in Figure 5.

Response:

The range of VWC should be 0-1, in the revised manuscript, we have changed it in Table 2. We also checked the unit of VWC in Figure 5, and found it is right.

(7) Figure 7, was this borehole drilled in 2010? Line 314, the authors stated that the borehole was drilled in Aug 2008. If the borehole was drilled in 2010, the ground temperatures measured in 2010 are not reasonable because of the disturbance of drilling. I also worry about the disturbance of drilling on the records during a couple of years in the beginning. The active layer might return to normal after one year. But the boreholes may not be.

Response:

Thanks for the comment. The borehole was drilled in August 2008, and then in mid-December 2008, the temperature probe was placed at a predetermined depth and monitored for the first time. From May 2009, permafrost temperature data for each half-hour was automatically recorded by a data logger. Therefore, the ground temperatures measured in 2010 are reasonable because it has been more than a year after the borehole was drilled.

To be clear, we added the installation time of thermistor probes in Permafrost temperature section as follows:

In mid-December 2008, twenty thermistors were installed at different depths in the borehole (0.1 m, 0.4 m, 0.9 m, 1.4 m, 1.9 m, 2.4 m, 3.4 m, 6.4 m, 7.4 m, 9.4 m, 11.4 m, 13.4 m, 15.4 m, 17.4 m, 19.4 m, 21.4 m, 23.4 m, 25.4 m, 27.4 m, and 28.4 m). (Line 367-370)

(8) Figure 7, the horizontal dashed line is 1.2m depth? It significantly departures from the scale (because it looks like at the middle of 0-5m).

Response:

We appreciate your careful review, we have changed the tick mark of the horizontal dashed line into “2 m”, which is as follows:

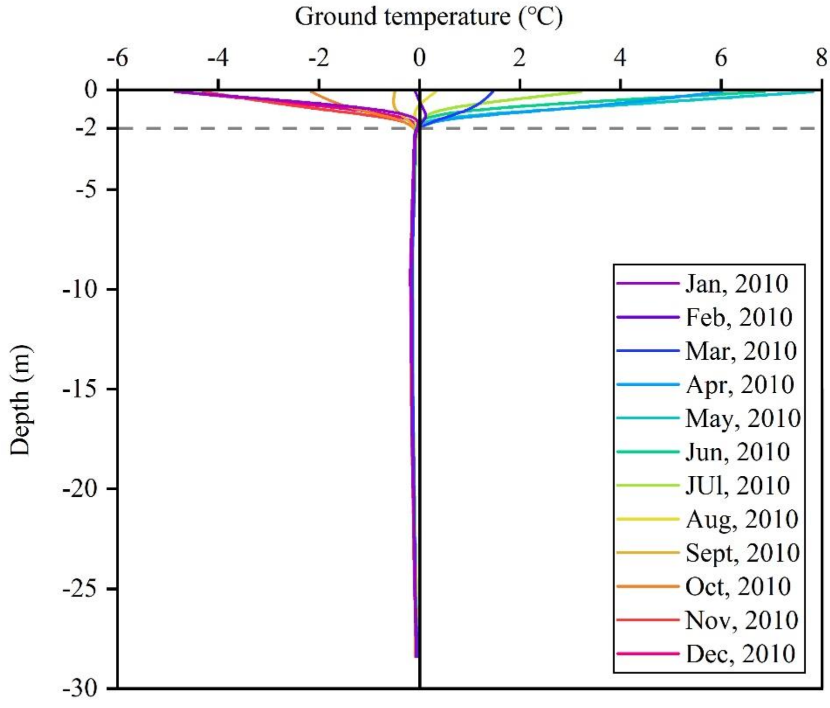

Figure 9. Ground temperature in the permafrost borehole drilled in 2010 at Mahan Mountain.

(9) Are the thermistors in the borehole shifting during the monitoring period? Are they calibrated every year or at a constant frequency in lab? Modern sensors and transmitters are electronic devices, and the reference voltage, or signal, may drift over time due to temperature, pressure, or change in ambient conditions.

Response:

To prevent the thermistors in the borehole shifting during the monitoring period, we setup a steel wire running through the borehole, and the cable wrapped with thermistors is fixed to the steel wire, which can ensure the cable is vertical and prevent the thermistors moving in the borehole.

In general, we calibrate these thermistors every year in the State Key Laboratory of Frozen Soil Engineering, Chinese Academy of Sciences. During the calibration process, another cable wrapped with similar thermistors is setup to guarantee data continuity. However, due to the sensor failure in 2012, then we manually measured the permafrost temperature using the cable wrapped with similar thermistors, these thermistors were also calibrated periodically to guarantee enough precision. To be clear, this information is added in the Data description section. (Line 134-144)

(10) Are the depths of all sensors in soil calibrated every year? Because thaw subsidence and frost heaven may have significant influences on the monitoring depths of soil sensors. In other words, after a couple of years, the sensors probably depart significantly from the initial depths.

Response:

Indeed, the thaw subsidence and frost heaven can exert significant influence on the monitoring depths of thermistors. As mentioned above, we have setup a steel wire running through the borehole, and the cable wrapped with thermistors is fixed to the steel wire, which can ensure the cable is vertical and prevent the thermistors shifting during the monitoring period. In fact, except the shallow or near surface soil temperature shows sharply variations, the ground temperature in other depths showed slight changes. For the sensors in the active layers, we cannot calibrate the depths of all sensors every year. Thanks for the suggestion. To be clear, we explained this in the methods section as follows:

However, for the sensors in the active layers, we cannot calibrate the depths of all sensors every year, which may lead to some errors. (Line 141-143)

2 A confusing point is that long-term MAAT is -1.4 (Line 120) while long-term MAGST is also -1.4 C (Line 171). As I know, generally, MAGST is higher than MAAT (including sites on the Qinghai-Tibetan Plateau, Alaska, and other permafrost sites). But at this site, they look equally. The authors have to explore and explain this feature.

Response:

Thank you very much for pointing this out. We are sorry for the mistake that the “GST” should be replaced by “LST”. The measured land surface temperature is the radiative skin temperature by the IRP-P at a height of 2 m. The surface could be snow, grass, and a mixture of them. Therefore, the variable should be

“LST”. We didn’t observe he ground surface temperature, the top depth of recorded soil temperature for active layer is 10 cm. We calculated local MAAT (2m) and MALST during observation period, which is -1.35°C and -1.43°C, respectively, so they are closely consistent. In the revised manuscript, we improved related descriptions.

3 The authors should calculate and explain the thermal offset, i.e., the difference between mean annual soil temperature at the bottom of the active layer and mean annual soil surface (~0cm) temperature (Romanovsky and Osterkamp, 1995). If the values in the manuscript are true, GST is -1.4C and MAGT at 2.4m is ~-0.1C. The offset would be roughly +1.3 C. The authors have to explain such a large reversed thermal offset (because it generally is negative. Of cause, some people (Lin et al., 2015; Luo et al., 2018) ‘found’ small positive offsets).

Response:

As stated in the above question, the value of MAGST is larger than +0.97°C (MAST at -10 cm). Therefore, the thermal offset = TTOP - MAGST= -0.1°C - (> +0.97°C) > -1.07°C (negative). The result is consistent with the general understanding for thermal offset in the permafrost regions. In the revised manuscript, we added related descriptions as follow:

Under the influence of the freeze–thaw process, the thermal state of the active layer is not constant during the whole year. In addition, the difference in thermal conductivity between the frozen and thawed ground causes a "negative thermal offset", which is defined as the difference between the mean annual soil temperature at the bottom of the active layer (TTOP) and the mean annual soil surface (~0 cm) temperature (MAGST) (Burn and Smith, 1988). In this study, the value of MAGST is larger than +0.97 °C (MAST at 10 cm). Therefore, the thermal offset = TTOP - MAGST= -0.1 °C - (> +0.97 °C) > -1.07 °C. This result is consistent with the general understanding of thermal offset in the permafrost regions (Romanovsky and Osterkamp, 1995). (Line 272-280)

References:

Burn, C. R., & Smith, C. A. S.: Observations of the" thermal offset" in near-surface mean annual ground temperatures at several sites near Mayo, Yukon Territory, Canada, Arctic, 99-104, https://www.jstor.org/stable/40510685, 1988.

Romanovsky, V. E., & Osterkamp, T. E.: Interannual variations of the thermal regime of the active layer and near-surface permafrost in northern Alaska. Permafrost and Periglacial Processes, 6(4), 313-335, https://doi.org/10.1002/ppp.3430060404, 1995.

4 References should be appropriate rather than load the manuscript with fancy references (same with the comment from Reviewer 1, however, I would indicate more specifically). An example is Line 39. Boike et al. (2019) only described a site-level dataset (like this manuscript) and gave not any hemispheric summary. Meanwhile, the authors should use terms (permafrost and permafrost region) correctly. Zhang et al. (1999) and Zhang et al. (2000) indicated that permafrost region underlies approximately 22.79 × 10^6 km^2 or 23.9% of the exposed land area of the Northern Hemisphere. Certainly, that permafrost may not be present everywhere within permafrost region. They present estimates that indicate that the actual area underlain by permafrost is smaller, ranging approximately from 12.21 to 16.98 × 10^6 km^2 (the source of 15 million km^2). Whatever, I don't know how only 15 million km2 can be 24% of the land surface area.

Response:

Thanks for pointing this out. In the revised version, we carefully checked all the references and made necessary changes. We also changed the sentences in the revised manuscript, which is as follows:

As a major component of the cryosphere, the area underlain by permafrost ranges from 12.21 × 10^6 km^2 to 16.98 × 10^6 km^2, or from 12.8% to 17.8% of the terrestrial landscape in the Northern Hemisphere (Zhang et al., 2000). (Line 34-37)

5 Finally, I totally agree with the comments from Reviewers 1 and 2. The language should be re-edited by English-native-speakers, although it is understandable but need readers to take heavy efforts.

Response:

Thanks for the suggestion. We polished our language by American Journal Experts (https://www.aje.com/) which is a partner of many publishing groups. The changes were highlighted in blue so that they may be easily identified. The editing certificate by AJE were presented as follows:

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Editing Certificate

This document certifies that the manuscript

Permafrost, active layer and meteorological data (2010–2020) from a relict permafrost site at Mahan Mountain, Northeast of Qinghai-Tibet Plateau

prepared by the authors

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